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Derivative UV Spectrophotometric Detection of Some Common Pesticides in Simulated Samples of Beverages

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Abstract

Pesticides are widely used in India because of their applications in agriculture and household purposes. Due to their high toxicity, over use and easy availability they are encountered in suicidal, accidental and homicidal cases. Poisoning with pesticides are common in developing countries as compared to western countries. Because of large number of cases of deaths due to pesticide poisoning it is imperative to develop sensitive, reliable and accurate methods for their detection from the viscera samples, biological materials and common substrates such as beverages etc. recovered from the crime scene. Derivative UV-Vis spectrophotometry is one of the most widely used techniques for detection of pesticides in viscera and other matrices such as beverages etc. In the present study, pesticides were spiked in beverages like Coffee, Tea, Fruity, Mountain dew and Alcohol and then analysed using derivative UV spectrophotometry. Further, the effect of matrices was studied on the UV spectra of pesticides.

Keywords: Pesticides; UV spectrophotometry; Toxicity; Beverages; Coffee; Tea; Fruity; Mountain dew and Alcohol.

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Introduction

Poisoning is a worldwide problem and pesticide poisoning is one of them and a major problem in developing countries such as India where it is the leading cause of accidental, homicidal and suicidal poisoning. Every year pesticide poisoning gain higher ranking due to its easy availability. Pesticide poisoning is a second major cause of death after road accidents. According to WHO in 2004, about 346,000 people had died due to unintentional poisoning and approximately 37000 had died due to intentional poisoning.[1]

India is an agrarian country where farming is main profession of over 60% population. Most of the farmers are rural based where the literacy rate is low. Pesticides are often used to increase the productivity of the crops which leads to the accidental exposure of farmers to pesticides. Due to unavailability of modern methods of production the financial condition of Indian farmers is poor. Because of easy availability, low cost, and low lethal dose the pesticides are often used for suicides. Another aspect which is related to pesticide poisoning is occupational poisoning; that is poisoning cases restricted to agriculture based professions[2,3]

Pesticides are also used as household insecticides which are sprayed to destroy pests and flies etc. Therefore, poisoning due to insecticides are growing day by day specially among children. Most of the cases of pesticide poisoning are encountered in Northern and North western parts of India because these are the major crops producing states. In these

regions, aluminium phosphide and other pesticides are the main reason of poisoning.[4]

Pesticide poisoning can be suicidal, homicidal or accidental. Almost, one million people had died due to suicidal poisoning in every year.[1] Use of pesticides have been banned since, therefore, there is a sharp decline in pesticide poisoning cases. However, accidental cases of pesticide poisoning are still reported due to uninhibited use of pesticides. Cases of homicidal poisoning are little as compared to suicidal and accidental because of disagreeable odour of pesticides.[5]

Various studies have been conducted for the analysis of different classes of pesticides using UV-VIS spectrophotometry. These include Insecticides [6–15], Fungicides[16–25], Insecticides[6–8,10,12,13,26–30], Herbicides.[21,31] Previous studies show that prevalence of high rate of pesticide poisoning cases in various regions of India such as in Panchkula[1], Jamnagar[32], Bangalore[33], Patiala[34], New Delhi[35], Karnataka[36], Ahmedabad[37], Rohtak[34], Uttar Pradesh [38], Himachal Pradesh[39], Western India[30], Manipur [40], Southern and Central India.[41]

Materials and Methods

Sample collection

Sample of common beverages include Coffee, Tea, Fruity, Soft drink (mountain dew), and Alcohol (Asli santra) (Table 1) and five pesticides like LUVON (Dichlorvous), ROGOR (Dimethoate), BAYGON (Carbamate), FINIT and HILMALA (Malathion) were collected from local market, Patiala. (Table 2 and 3).

Preparation of standards – 3 µl of each pesticide (luvon, rogor, baygon, finit and hilmala) were dissolved in 3 ml of cyclohexane and n- Hexane, respectively.

Preparation of simulate samples

For the preparation of simulated samples two different methods were followed. (Table 4). 20 ml sample of each beverage was taken separately into five beakers and marked accordingly. The beverages were then spiked using 2 ml of each pesticide. After shaking mixture was kept overnight. Next day, 10 ml of sample was taken and extracted 3 times with 15 ml of n- Hexane portions in 60 ml of separating funnel. The hexane layers were then combined and passed through anhydrous sodium sulphate to remove water and evaporated to dryness. The residue so obtained was tested for the presence of pesticides in the samples. Same procedure was followed for all beverages.

Analysis of prepared samples

Prepared samples were analysed using UV 1700 (Shimadzu, Japan). UVProbe 2.0 software was used for recording all readings as well as transformation into first and second derivative. Instrumental parameters used in the present study include a scan range of 225–400 nm in absorbance mode and fast scan speed.

Results

(a) Results of analysis of standards spiked in n-hexane

The zero order spectrum of Luvon in n-hexane shows maxima at 388 nm, 258.5 nm and minima at 253 nm. The zero order spectrum of Rogor in n-hexane shows maxima at 259 nm and 234 nm and minima at 253.5 nm and 230 nm. The zero order spectrum of Baygon in n-hexane shows maxima

Table 1: Name of substrate along with coding

S. No.	Name of substrate	Coding
1	Coffee	C
2	Tea	T
3	Fruity	F
4	Mountain dew	M
5	Alcohol	A

Table 2: Name of Pesticides along with coding

S. No.	Name of pesticides	Coding
1.	Luvon	1
2.	Rogor	2
3.	Baygon	3
4.	Finit	4
5.	Hilmala	5

at 388 nm, 328.5 nm and 258 nm and minima at 354.5 nm, 319.5 nm and 252 nm. The zero order spectrum of Finit in n-hexane shows maxima at 260.5 nm and minima at 251 nm. The zero order spectrum of Hilmala in n-hexane shows maxima at 264.5 nm and minima at 264.5 nm (Fig.1).

The first order spectrum of Luvon in n-hexane shows maxima at 325 nm, 300 nm, 290.5 nm, 256 nm and 230 nm and minima at 335 nm, 307.5 nm, 295 nm, 276 nm and 238.5 nm. The first order spectrum of Rogor in n-hexane shows maxima at 325 nm, 291 nm, 256 nm and 232.5 nm and minima at 336.5 nm, 307.5 nm, 278 nm, 270.5 nm and 241.5 nm. The first order spectrum of Baygon in n-hexane shows maxima at 324 nm and 255.5 nm and minima at 306 nm, 276.5 nm and 235.5 nm. The first order spectrum of Finit in n-hexane shows maxima at 323.5 nm, 302 nm, 290.5 nm and 256 nm and minima at 336 nm, 305.5 nm, 295 nm, 280 nm and 229.5 nm. The first order spectrum of Hilmala in n-hexane shows maxima at 303 nm, 283.5 nm, 271.5 nm and 255 nm and minima at 306 nm, 288.5 nm,

Table 3: Commercial name of pesticides along with composition

S. No.	Commercial Name	Pesticide (Main component)	Composition
1.	Luvon 76% EC (Insecticide)	Dichlorvous	DDVP a.i : 76% w/w Adjuvants : Q.S Total : 100% w/w
2.	Rogor (Insecticide)	Dimethoate	Dimethoate technical (based on 85% w/w a.i) : 35.5% Epichlorohydrin (stabilizer) : 1.0% Emulsifier (nonionic polyoxy ethylene ether) : 8.0% Aromax : 10.5% Xylene : 30.0% Cyclohexanone : 15.0% Total : 100%
3.	Baygon (All insect kiler)	Carbamate	Deltamethrin a.i : 0.05% Allethrin a.i : 0.04% Adjuvants : Q.S% Total : 100%
4.	Finit (Multi insect killer)	Malathion	Pyrothrins : 0.05 w/w Malathion : 1.0 w/w Kerosene base and perfume : Q.S Total : 100% w/w
5.	Hilmala 50 EC (Insecticide)	Malathion	Malathion technical : 52.8% w/w (based on 95% w/w a.i) Stabilizer (Epichlorhydrin) : 1.05 w/w Emulsifier (alkyl aryl Sulphonate and polyoxy ethylene ether) : 5.0% w/w Aromax : 41.2% Total : 100.0% w/w

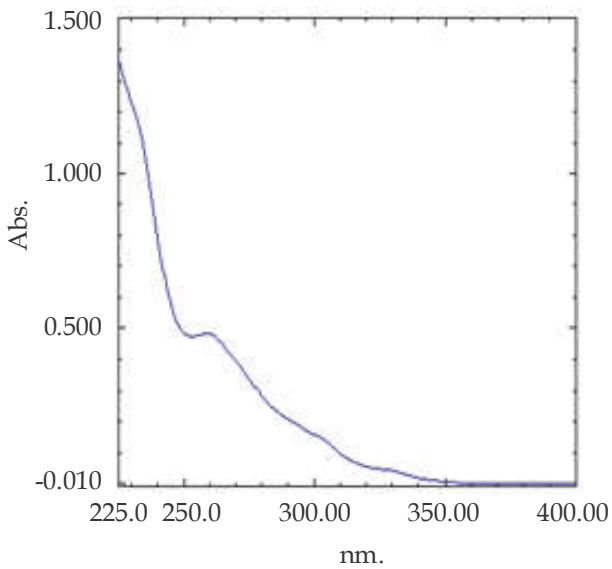

Fig. 1: Zero order spectrum of Luvon in n-hexane

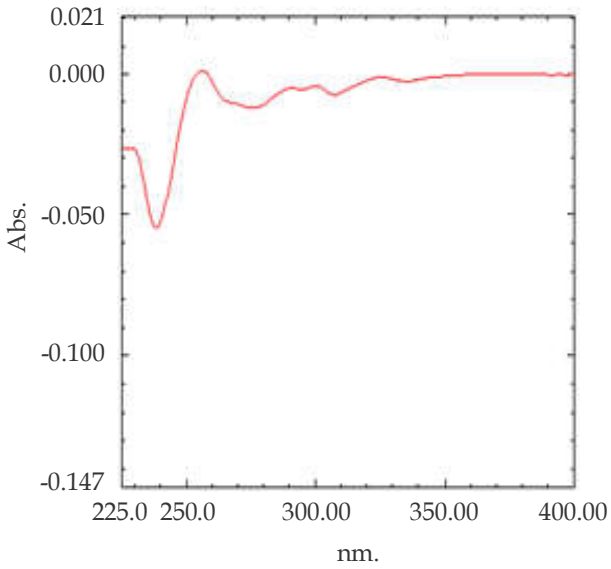

Fig. 2: First order spectrum of Luvon in n-hexane

278.5 nm, 268.5 nm and 229.5 nm (Fig. 2).

The second order spectrum of Luvon in n-hexane shows maxima at 298 nm and 244.5 nm and minima at 303.5 nm, 260.5 nm and 234 nm. The second order spectrum of Rogor in n-hexane shows maxima at 272.5 nm and 249 nm and minima at 260.5 nm and 235.5 nm. The second order spectrum of Baygon in n-hexane shows maxima at 244.5 nm and minima at 232.5 nm. The second order spectrum of Finit in n-hexane shows maxima at 298 nm, 283 nm, 245 nm and 232 nm and minima at 292.5 nm, 260.5 nm and 240.5 nm. The second order spectrum of Hilmala in n-hexane shows maxima at 297 nm, 290.5 nm, 281.5 nm, 269.5 nm, 260 nm, 250 nm and 232 nm and minima at 305 nm, 294 nm, 286.5 nm, 276 nm, 265 nm, 256.5 nm and 240.5 nm (Fig. 3).

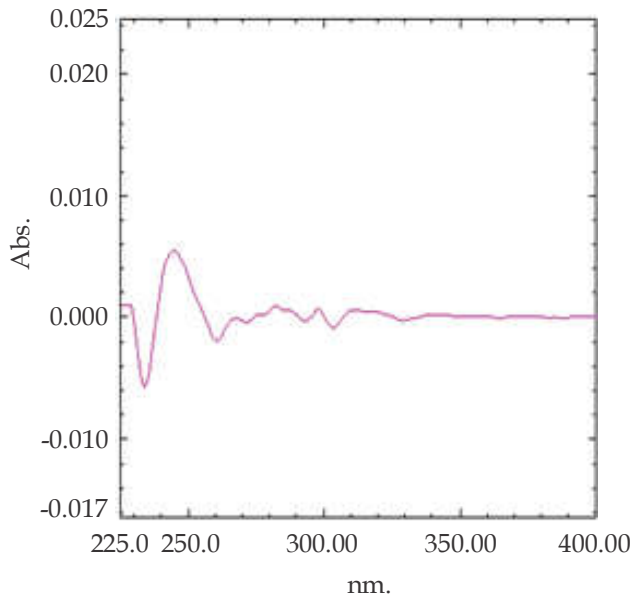

Fig. 3: Second order spectrum of Luvon in n-hexane

Table 4: Name of spiked samples

S. No.	Name of spiked samples	Coding
1	Coffee with Luvon	C 1
2	Coffee with Rogor	C 2
3	Coffee with Baygon	C 3
4	Coffee with Finit	C 4
5	Coffee with Hilmala	C 5
6	Tea with Luvon	T 1
7	Tea with Rogor	T 2
8	Tea with Baygon	T 3
9	Tea with Finit	T 4
10	Tea with Hilmala	T 5
11	Fruity with Luvon	F 1
12	Fruity with Rogor	F 2
13	Fruity with Baygon	F 3
14	Fruity with Finit	F 4
15	Fruity with Hilmala	F 5
16	Mountain dew with Luvon	M 1
17	Mountain dew with Rogor	M 2
18	Mountain dew with Baygon	M 3
19	Mountain dew with Finit	M 4
20	Mountain dew with Hilmala	M 5
21	Alcohol with Luvon	A 1
22	Alcohol with Rogor	A 2
23	Alcohol with Baygon	A 3
24	Alcohol with Finit	A 4
25	Alcohol with Hilmala	A 5

b) Results of analysis of pesticides in various substrates extracted using n- hexane as solvent (Table 5 to 9).

The zero order spectrum of Luvon in coffee (C1) shows maxima at 388 nm and 265.5 nm and minima at 317.5 nm and 256.5 nm. The zero order spectrum of Rogor in coffee (C2) shows maxima at 388 nm and 266 nm and minima at 390 nm, 346 nm, 320.5 nm and 249 nm. The zero order spectrum of Baygon in

Table 5: Results of Luvon extracted using n-hexane from different beverages

Spectrum order	Luvon (neat)		C1		T1		F1		M.D1		A1	
	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)
Zero	388	253	388	317.5	388	392	388	372.5	577	579.5	259	254
	258.5		265.5	256.5	329	354.5	259.5	253	565	567		
						320	232	229	557.5	562		
									520.5	550		
									512	514.5		
									493	508		
									466.5	491		
									458.5	464.5		
									418	456.5		
									394.5	416		
									293	392.5		
									283.5	291		
									262.5	280		
									251.5	260		
									237.5	243		
										229		
First	325	335	299.5	278	300	278.5	325	337	394	398.5	327.5	338
	300	307.5	261.5		259	229.5	291	308	373	377.5	302	309
	290.5	295					256.5	273	363.5	367.5	291	295.5
	256	276					230.5	240	345.5	351.5	256.5	278
	230	238.5							327.5	338.5	233.5	238.5
									303.5	310		
									290	296.5		
									281.5	286.5		
									269	276.5		
									259	266		
									246	252.5		
									232	239		
Second	298	303.5	280.5	276	Nil	Nil	247	260.5	417	413	298.5	304
	244.5	260.5	249	234.5				235	404	396	272.5	293
		234	229.5						391	388.5	245	276
									379	376	229.5	260
									371.5	366		235.5
									360.5	349.5		
									341	338		
									313	307		
									296.5	292		
									289	284		
									276.5	270.5		
									266	263.5		
									259.5	257		
									255	251.5		
									248	234.5		
									230.5			

coffee (C3) shows maxima at 338 nm and 267 nm and minima at 340 nm, 309 nm and 260.5 nm. The zero order spectrum of Finit in coffee (C4) shows maxima at 322 nm and 267.5 nm and 332 nm, 317 nm and 246 nm. The zero order spectrum of Hilmala (C5) shows maxima at 319.5 nm, 311.5 nm, 274 nm and 266 nm and minima at 322 nm, 317 nm, 309.5 nm, 269.5 nm and 246.5 nm (Fig. 4).

Table 6: Results of Rogor extracted using n-hexane from different beverages

Spectrum Order	Rogor (neat)		C2		T2		F2		M.D2		A2	
	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)
Zero	259	253.5	388	390	388	390	388	390	587	584	266	310
	234	230	266	346	266	317	266.5	306.5	577.5	567		240
				320.5		255.5		289.5	558	549.5		
				249				237	546	542		
									533.5	527		
									512	491.5		
									504	482		
									487	474.5		
									476.5	452		
									454	443		
									445.5	425.5		
									433.5	403.5		
									408	384		
									390	358		
									365.5	340.5		
									342.5	254		
									266			
First	325	336.5	324	278	322	278	293.5	278	414.5	410.5	294	278
	291	307.5	302	270	272	269.5	272	270	405	399.5	272	269.5
	256	278	272		263	246	262.5		387.5	369	262.5	
	232.5	270.5	257.5		244		255.5		361.5	355	255.5	
		241.5							349.5	346.5		
									339.5	332.5		
									302	278		
									272	270		
									262.5			
Second	272.5	260.5	280.5	275.5	280.5	287	280.5	275.5	412	415.5	280.5	275.5
	249	235.5	271	266.5	271	275.5	271	266.5	404	407.5	271	266.5
			262	259.5	262	266.5	262		394	396	262	245.5
			250	245	231	259.5	229.5		386	390.5	229.5	
			230.5			245			379	383.5		
									369	376.5		
									357.5	365.5		
									352	354		
									346.5	350		
									339	342.5		
									280.5	333.5		
									271	287.5		
									262	275.5		
									231	266.5		
										259.5		

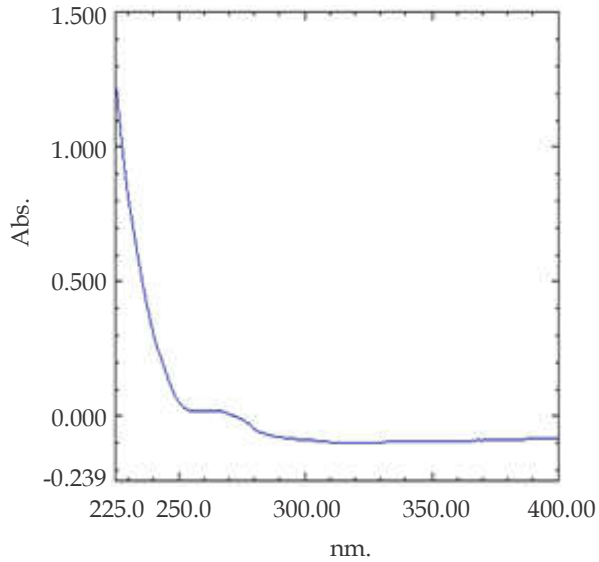

Fig. 4: Zero order spectrum of C1 in n-hexane

Table 7: Results of Baygon extracted using n-hexane from different beverages

Spectrum Order	Baygon (neat)		C3		T3		F3		M.D3		A3	
Zero	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)
	388	354.5	338	340	388	390.5	388	253	598	588.5	265	254.5
	328.5	319.5	267	309	267	308.5	259.5		581	562.5		
	258	252		260.5		261.5	232		564.5	541.5		
									557	528		
									544	488.5		
									540	451		
									512	426		
									472	419		
									428	410		
									421	402.5		
									412	360		
									408	257		
									375			
									259.5			
First	324	306	264	286.5	264.5	287	325.5	338	405.5	400.5	321.5	287.5
	255.5	276.5		236.5		238	302	308.5	396	392.5	302	281.5
		235.5					291	281.5	385.5	378	258.5	233.5
							278	271.5	371.5	369		
							256	240	362.5	356.5		
									354	346.5		
									340	335		
									259	229.5		
Second	244.5	232.5	250.5	266.5	292	267	286	279.5	403.5	406.5	282.5	286.5
			241	244	251	244	275	261	393.5	398.5	270	277.5
				233.5	241	233.5	246	235	381.5	390.5	242.5	266
					230.5				370.5	376		
									361	364		
									339.5	342.5		

The zero order spectrum of Luvon in tea (T1) shows maxima at 388 nm and 329 nm and minima at 392 nm, 354.5 nm and 320 nm. The zero order spectrum of Rogor in tea (T2) shows maxima at 388 nm and 266 nm and minima at 390 nm, 317 nm and 255.5 nm. The zero order spectrum of Baygon in tea (T3) shows maxima at 388 nm and 267 nm and minima at 390.5 nm, 308.5 nm and 261.5 nm. The zero order spectrum of Finit in tea (T4) shows maxima at 388 nm, 322.5 nm and 267.5 nm and minima at 390 nm, 335 nm, 317.5 nm and 247 nm. The zero order spectrum of Hilmala in tea (T5) shows maxima at 388 nm, 319.5 nm, 311.5 nm, 272.5 nm and 265.5 nm and minima at 390 nm, 322.5 nm, 317 nm, 309.5 nm 269.5 nm and 250 nm.

The zero order spectrum of Luvon in fruity (F1) shows maxima at 388 nm, 259.5 nm, 232 nm, 325 nm, 291 nm, 256.5 nm and 230.5 nm and minima at 372.5 nm, 253 nm, 229 nm, 337 nm, 308 nm, 273 nm and 240 nm. The zero order spectrum of Rogor in fruity (F2) shows maxima at 388 nm and 266.5 nm and minima at 390 nm, 306.5 nm, 289.5 nm and 237 nm. The zero order spectrum of Baygon in fruity (F3) shows maxima at 388 nm and 259.5 nm and minima at 253 nm. The zero order spectrum of Finit in fruity (F4) shows maxima at 388 nm and 322 nm and minima at 335 nm and 317.5 nm. The zero order spectrum of Hilmala in fruity (F5) shows maxima at 388 nm, 319 nm, 311.5 nm, 274 nm and 265.5 nm and minima at 389 nm, 317.5 nm, 309.5 nm, 269.5 nm and 248 nm.

Table 8: Results of Finit extracted using n-hexane from different beverages

Spectrum Order	Finit (neat)		C4		T4		F4		M.D4		A4	
	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)
Zero	260.5	251	322	332	388	390	388	335	575.5	591.5	388	312.5
			267.5	317	322.5	335	322	317.5	532.5	549	272	270
				246	267.5	317.5	267.5	245	520	522	267.5	244
						247			510.5	515.5		
									493	502		
									472.5	481.5		
									468	470.5		
									449	463.5		
									441	447		
									398.5	438		
									265	393		
										249		
First	323.5	336	320	326	320	326	320	326	406	410.5	320	295
	302	305.5	288	294.5	288.5	294.5	288.5	294.5	395.5	402	288.5	278.5
	290.5	295	258	279.5	258	278	257.5	279.5	382.5	385.5	256	230
	256	280		234		233		233.5	373	378		
		229.5							363.5	369		
									343	348.5		
									321	336		
									289.5	295		
									257	280		
										234		
Second	298	292.5	297.5	322.5	297.5	292.5	297.5	322.5	411.5	408	282	273.5
	283	260.5	282	292.5	282	273.5	282	292.5	404	399.5	269.5	266
	245	240.5	269.5	273.5	269.5	266.5	269.5	273.5	394.5	389.5	233.5	
	232		237	266.5	236	230.5	236.5	253	386.5	383		
				231.5				231	379	376		
									371	366		
									361	346		
									298	293		
									282.5	273		
									269.5	266		
									236	230.5		

The zero order spectrum of Luvon in mountain dew (M1) shows maxima at 577 nm, 565 nm, 557.5 nm, 520.5 nm, 512 nm, 493 nm, 466.5 nm, 458.5 nm, 418 nm, 394.5 nm, 293 nm, 283.5 nm, 262.5 nm, 251.5 nm and 237.5 nm and minima at 579.5 nm, 567 nm, 562 nm, 550 nm, 514.5 nm, 508 nm, 491 nm, 464.5 nm, 456.5 nm, 416 nm, 392.5 nm, 291 nm, 280 nm, 260 nm, 243 nm and 229 nm. The zero order spectrum of Rogor in mountain dew (M2) shows maxima at 587 nm, 577.5 nm, 558 nm, 546 nm, 533.5 nm, 512 nm, 504 nm, 487 nm, 476.5 nm, 454 nm, 445.5 nm, 433.5 nm, 408 nm, 390 nm, 365.5 nm, 342.5 nm and 266 nm and minima at 584 nm, 567 nm, 549.5 nm, 542 nm, 527 nm, 491.5 nm, 482 nm, 474.5 nm, 452 nm, 443 nm, 425.5 nm, 403.5 nm, 384 nm, 358 nm, 340.5 nm and 254 nm. The zero order spectrum of Baygon in mountain dew (M3) shows

Table 9: Results of Hilmala extracted using n-hexane from different beverages

Spectrum Order	**Hilmala (neat)**		**C5**		**T5**		**F5**		**M.D5**		**A5**	
	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimum (nm)	Maximum (nm)	Minimusm (nm)	Maximum (nm)	Minimum (nm)
Zero	264.5	250.5	319.5	322	388	390	388	389	597	570	388	390
			311.5	317	319.5	322.5	319	317.5	561	550.5	319.5	321.5
			274	309.5	311.5	317	311.5	309.5	548	543.5	311.5	315.5
			266	269.5	272.5	309.5	274	269.5	524	504	274.5	309
				246.5	265.5	269.5	265.5	248	486	479	265.5	269
						250			464	451		247.5
									441.5	436.5		
									408	403		
									379	369.5		
									365	360		
									348.5	346		
									272	270		
									265	251		
First	303	306	318.5	314	303	289	319	314	423.5	428.5	283.5	289
	283.5	288.5	283.5	289	283.5	278.5	303.5	289	413.5	419.5	271.5	278.5
	271.5	278.5	271.5	278.5	271.5	268	283.5	278.5	407	411	262	268
	255	268.5	262	268	261.5	229.5	271.5	268	387.5	399.5	254.5	
		229.5	254	256.5	254.5		261.5	256.5	373	381		
				230.5			254	230.5	361	366.5		
									350	352		
									341	347.5		
									320	332		
									302.5	306		
									283.5	289		
									271	278.5		
									261.5	268		
									254.5	257		
										234		
Second	297	305	315.5	320	290.5	305	315.5	320	421	426417	291	286.5
	290.5	294	308.5	312.5	280.5	294	308.5	312.5	414	409.5	280.5	275.5
	281.5	286.5	291	305	269.5	286	296.5	305.5	404	399.5	269.5	265
	269.5	276	280.5	294	260	275.5	291	294	382.5	377.5	260	256
	260	265	269.5	286	250	265.5	280.5	286.5	368	365.5	251	247
	250	256.5	260	275.5	232	256	269.5	275.5	360	343	231.5	
	232	240.5	250.5	265.5			260	265	339.5	333.5		
			233	255.5			251	256	315.5	320		
				247			233	247	308.5	312.5		
									297	305		
									291	294		
									280.5	286		
									269.5	275		
									260	265		
									242.5	256		
										230.5		

maxima at 598 nm, 581 nm, 564.5 nm, 557 nm, 544 nm, 540 nm, 512 nm, 472 nm, 428 nm, 421 nm, 412 nm, 408 nm, 375 nm and 259.5 nm and minima at 588.5 nm, 562.5 nm, 541.5 nm, 528 nm, 488.5 nm, 451 nm, 426 nm, 419 nm, 410 nm, 402.5 nm, 360 nm and 257 nm. The zero order spectrum of Finit in mountain dew (M4) shows maxima at 575.5 nm, 532.5 nm, 520 nm, 510.5 nm, 493 nm, 472.5 nm, 468 nm, 449 nm, 441 nm, 398.5 nm and 265 nm and minima at 591.5 nm, 549 nm, 522 nm, 515.5 nm, 502 nm, 481.5 nm, 470.5 nm, 463.5 nm, 447 nm, 438 nm, 393 nm and 249 nm. The zero order spectrum of Hilmala in mountain dew (M5) shows maxima at 597 nm, 561 nm, 548 nm, 524 nm, 486 nm, 464 nm, 441.5 nm, 408 nm, 379 nm, 365 nm, 348.5 nm, 272 nm and 265 nm and minima at 570 nm, 550.5 nm, 543.5 nm, 504 nm, 479 nm, 451 nm, 436.5 nm, 403 nm, 369.5 nm, 360 nm, 346 nm, 270 nm and 251 nm.

The zero order spectrum of Luvon in alcohol (A1) shows maxima at 259 nm and minima at 254 nm. The zero order spectrum of Rogor in alcohol (A2) shows maxima at 266 nm and minima at 310 nm and 240 nm. The zero order spectrum of Baygon in alcohol (A3) shows maxima at 265 nm and 254.5 nm. The zero order spectrum of Finit in alcohol (A4) shows maxima at 388 nm, 272 nm and 267.5 nm and minima at 312.5 nm, 270 nm and 244 nm. The zero order spectrum of Hilmala in alcohol (A5) shows maxima at 388 nm, 319.5, 311.5 nm, 274.5 nm and 265.5 nm and minima at 390 nm, 321.5 nm, 315.5 nm, 309 nm 269 nm and 247.5 nm.

The first order spectrum of Luvon in coffee (C1) shows maxima at 299.5 nm and 261.5 nm and minima at 278 nm. The first order spectrum of Rogor in coffee (C2) shows maxima at 324 nm, 302 nm, 272 nm and 257.5 nm and minima at 278 nm and 270 nm. The first order spectrum of Baygon in coffee (C3) shows maxima at 264 nm and minima at 286.5 nm and 236.5 nm. The first order spectrum of Finit in coffee (C4) shows maxima at 320 nm, 288 nm and 258 nm and minima at 326 nm, 294.5 nm, 279.5 nm and 234 nm. The first order spectrum of Hilmala in coffee (C5) shows maxima at 318.5 nm, 283.5 nm, 271.5 nm, 262 nm and 254 nm and minima at 314 nm, 289 nm, 278.5 nm, 268 nm, 256.5 nm and 230.5 nm (Fig. 5).

The first order spectrum of Luvon in tea (T1) shows maxima at 388 nm and 329 nm and minima at 278.5 nm and 229.5 nm. The first order spectrum of Rogor in tea (T2) shows maxima at 322 nm, 272 nm, 263 nm and 244 nm and minima at 278 nm, 269.5 nm and 246 nm. The first order spectrum of Baygon in tea (T3) shows maxima at 264.5 nm and minima at 287 nm and 238 nm. The first order spectrum of Finit in tea (T4) shows maxima at 320 nm, 288.5 nm and 258 nm and minima at 326 nm, 288.5 nm and 258 nm. The first order spectrum of Hilmala in tea (T5) shows maxima at 303 nm, 283.5 nm, 271.5 nm, 261.5 nm and 254.5 nm and minima at 289 nm, 278.5 nm, 268 nm and 229.5 nm.

The first order spectrum of Luvon in fruity (F1) shows maxima at 325 nm, 291 nm, 256.5 nm and 230.5 nm and minima at 337 nm, 308 nm, 273 nm and 240 nm. The first order spectrum of Rogor in fruity (F2) shows maxima at 293.5 nm, 272 nm, 262.5 nm and 255.5 nm and minima at 278 nm and 270 nm. The first order spectrum of Baygon in fruity (F3) shows maxima at 325.5 nm, 302 nm, 291 nm, 278 nm and 256 nm and minima at 338 nm,

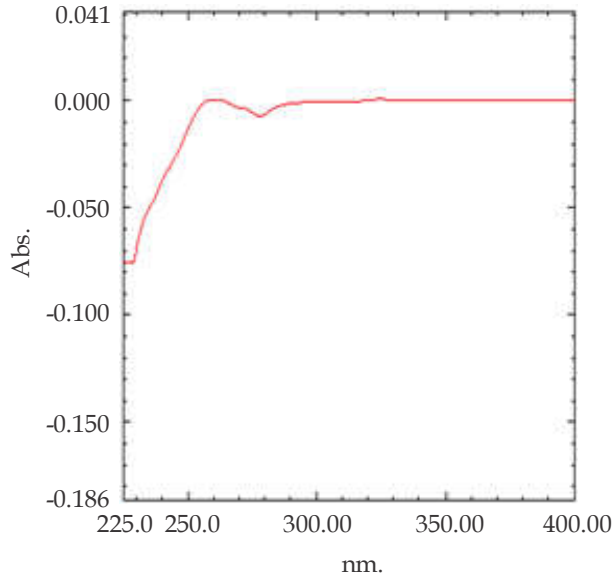

Fig. 5: First order spectrum of C1 in n-hexane

308 nm, 281.5 nm, 271.5 nm and 240 nm. The first order spectrum of Finit in fruity (F4) shows maxima at 320 nm, 288.5 nm and 257.5 nm and minima at 326 nm, 294.5 nm, 279.5 nm and 233.5 nm. The first order spectrum of Hilmala in fruity (F5) shows maxima at 319 nm, 303.5 nm, 283.5 nm, 271.5 nm, 261.5 nm and 254 nm and minima at 314 nm, 289 nm, 278.5 nm, 268 nm, 256.5 nm and 230.5 nm.

The first order spectrum of Luvon in mountain dew (M1) shows maxima at 394 nm, 374 nm, 363.5 nm, 345.5 nm, 327.5 nm, 303.5 nm, 290 nm, 281.5 nm, 269 nm, 259 nm, 246 nm and 232 nm and minima at 298.5 nm, 277.5 nm, 367.5 nm, 351.5 nm, 338.5 nm, 310 nm, 296.5 nm, 286.5 nm, 276.5 nm, 266 nm, 252.5 nm and 239 nm. The first order spectrum of Rogor in mountain dew (M2) shows maxima at 414.5 nm, 404 nm, 387.5 nm, 361.5 nm, 349.5 nm, 339.5 nm, 302 nm, 272 nm and 262.5 nm and minima at 410.5 nm, 399.5 nm, 369 nm, 355 nm, 346.5 nm, 332.5 nm, 278 nm and 270 nm. The first order spectrum of Baygon in mountain dew (M3) shows maxima at 405.5 nm, 396 nm, 385.5 nm, 371.5 nm, 362.5 nm, 354 nm, 340 nm and 259 nm and minima at 400.5 nm, 392.5 nm, 378 nm, 369 nm, 356.5 nm, 346.5 nm, 335 nm and 229.5 nm. The first order spectrum of Finit in mountain dew (M4) shows maxima at 406 nm, 395.5 nm, 382.5 nm, 373 nm, 363.5 nm, 343 nm, 321 nm, 289.5 nm and 257 nm and minima at 410.5 nm, 402 nm, 385.5 nm, 378 nm, 369 nm, 348.5 nm, 336 nm, 295 nm, 280 nm and 234 nm. The first order spectrum of Hilmala in mountain dew (M5) shows maxima at 423.5 nm, 413.5 nm, 407 nm, 387.5 nm, 373 nm, 361 nm, 350 nm, 341 nm, 320 nm, 302.5 nm, 283.5 nm, 271 nm, 261.5 nm and 254.5 nm and minima at 428.5 nm, 419.5 nm, 411 nm, 399.5 nm, 381 nm, 366.5 nm, 352 nm, 347.5 nm, 332 nm, 306 nm, 289 nm, 278.5 nm, 268 nm, 257 nm and 234 nm.

The first order spectrum of Luvon in alcohol (A1) shows maxima at 327.5 nm, 302 nm, 291 nm, 256.5 nm and 233.5 nm and minima at 338 nm, 309 nm, 295.5 nm, 278 nm and 238.5 nm. The first order spectrum of Rogor in alcohol (A2) shows maxima at 294 nm, 272 nm, 262.5 nm and 255.5 nm and minima at 278 nm and 269.5 nm. The first order spectrum of Baygon in alcohol (A3) shows maxima at 321.5 nm, 302 nm and 258.5 nm and minima at 287.5 nm, 281.5 nm and 233.5 nm. The first order spectrum of Finit in alcohol (A4) shows maxima at 320 nm, 288.5 nm and 256 nm and 295 nm, 278.5 nm and 230 nm. The first order spectrum of Hilmala in alcohol (A5) shows maxima at 283.5 nm, 271.5 nm, 262 nm and 254.5 nm and minima at 289 nm, 278.5 nm and 268 nm.

The second order spectrum of Luvon in coffee (C1) shows maxima at 280.5 nm, 249 nm and 229.5 nm and minima at 276 nm and 234.5 nm. The second order spectrum of Rogor in coffee (C2) shows maxima at 280.5 nm, 271 nm, 262 nm, 250 nm and 230.5 nm and minima at 275.5 nm, 266.5 nm, 259.5 nm and 245 nm. The second order spectrum of Baygon in coffee (C3) shows maxima at 250.5 nm and 241 nm and minima at 266.5 nm, 244 nm and 233.5 nm. The second order spectrum of Finit in coffee (C4) shows maxima at 297.5 nm, 282 nm, 269.5 nm and 237 nm and minima at 322.5 nm, 292.5 nm, 273.5 nm, 266.5 nm and 231 nm. The second order spectrum of Hilmala in coffee (C5) shows maxima at 315.5 nm, 308.5 nm, 291 nm, 280.5 nm, 269.5 nm, 260 nm, 250.5 nm and 233 nm and minima at 320 nm, 312.5 nm, 305 nm, 294 nm, 286 nm, 275.5 nm, 265.5 nm, 255.5 nm and 247 nm. (Fig. 6).

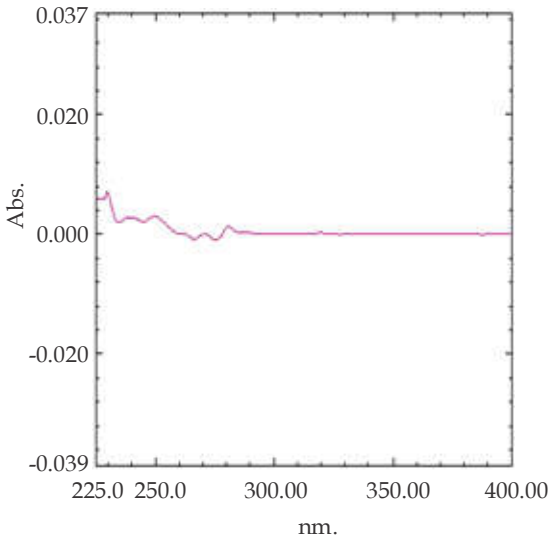

Fig. 6: Second order spectrum of C1 in n-hexane

The second order spectrum of Luvon in tea (T1) is nil. The second order spectrum of Rogor in tea (T2) shows maxima at 280.5 nm, 271 nm, 262 nm and 231 nm and minima at 287 nm, 275.5 nm, 266 nm, 259.5 nm and 245 nm. The second order spectrum of Baygon in tea (T3) shows maxima at 292 nm, 251 nm, 241 nm and 230.5 nm and minima at 267 nm, 244 nm and 233.5 nm. The second order spectrum of Finit in tea (T4) shows maxima at 297.5 nm, 282 nm, 269.5 nm and 236 nm and minima at 292.5 nm, 273.5 nm, 266.5 nm and 230.5 nm. The second order spectrum of Hilmala in tea (T5) shows maxima at 290.5 nm, 280.5 nm, 269.5 nm, 260 nm, 250 nm and 232 nm and minima at 305 nm, 294 nm, 286 nm, 275.5 nm, 265.5 nm and 256 nm.

The second order spectrum of Luvon in fruity (F1) shows maxima at 247 nm and 260.5 nm and 235 nm. The second order spectrum of Rogor in fruity (F2) shows maxima at 280.5 nm, 271 nm, 262 nm and 229.5 nm and minima at 275.5 nm and 266.5 nm. The second order spectrum of Baygon in fruity (F3) shows maxima at 286 nm, 275 nm and 246 nm and minima at 279.5 nm, 261 nm and 235 nm. The second order spectrum of Finit in fruity (F4) shows maxima at 297.5 nm, 282 nm, 269.5 nm and 236.5 nm and minima at 322.5 nm, 292.5 nm, 273.5 nm, 253 nm and 231 nm. The second order spectrum of Hilmala in fruity (F5) shows maxima at 315.5 nm, 308.5 nm, 296.5 nm, 291, 280.5, 269.5 nm, 260 nm, 251 nm and 233 nm and 320 nm, 312.5 nm, 305.5 nm, 294 nm, 286.5 nm, 275.5 nm, 265 nm, 256 nm and 247 nm.

The second order spectrum of Luvon in mountain dew (M1) shows maxima at 417 nm, 404 nm, 391 nm, 379 nm, 371.5 nm, 360.5 nm, 341 nm, 313 nm, 296.5 nm, 289 nm, 276.5 nm, 266 nm, 259.5 nm, 255 nm, 248 nm and 230.5 nm and minima at 413 nm, 396 nm, 388.5 nm, 376 nm, 366 nm, 349.5 nm, 338 nm, 307 nm, 292 nm, 284 nm, 270.5 nm, 263.5 nm, 257 nm, 251.5 nm and 234.5 nm. The second order spectrum of Rogor in mountain dew (M2) shows maxima at 412 nm, 404 nm, 394 nm, 386 nm, 379 nm, 369 nm, 357.5 nm, 352 nm, 346.5 nm, 339 nm, 280.5 nm, 271 nm, 262 nm and 231 nm and minima at 415.5 nm, 407.5 nm, 396 nm, 390.5 nm, 383.5 nm, 376.5 nm, 365.5 nm, 354 nm, 350 nm, 342.5 nm, 333.5 nm, 287.5 nm, 275.5 nm, 266.5 nm, 259.5 nm. The second order spectrum of Baygon in mountain dew (M3) shows maxima at 403.5 nm, 393.5 nm, 381.5 nm, 370.5 nm, 361 nm and 339.5 nm and minima at 406.5 nm, 398.5 nm, 390.5 nm, 376 nm, 364 nm, 342.5 nm. The second order spectrum of Finit in mountain dew (M4) shows maxima at 411.5 nm, 404 nm, 394.5 nm, 386.5 nm, 379 nm, 371 nm, 361 nm, 298 nm, 282.5 nm, 269.5 nm and 236 nm and minima at 408 nm, 399.5 nm, 389.5 nm, 383 nm, 376 nm, 366 nm, 346 nm, 293 nm, 273 nm, 266 nm and 230.5 nm. The second order spectrum of Hilmala in mountain dew (M5) shows maxima at 421 nm, 414 nm, 404 nm, 382.5 nm, 368 nm, 360 nm, 339.5 nm, 315.5 nm, 308 nm, 297 nm, 291 nm, 280.5 nm, 269.5 nm, 260 nm and 242.5 nm and minima at 426 nm, 417 nm, 409.5 nm, 399.5 nm, 377.5 nm, 365.5 nm, 343 nm, 333.5 nm, 320 nm, 312.5 nm, 305 nm, 294 nm, 286 nm, 275 nm, 265 nm, 256 nm and 230.5 nm.

The second order spectrum of Luvon in alcohol (A1) shows maxima at 298.5 nm, 272.5 nm, 245 nm and 229.5 nm and minima at 304 nm, 293 nm, 276 nm, 260 nm and 235.5 nm. The second order spectrum of Rogor in alcohol (A2) shows maxima at 280.5 nm, 271 nm, 262 nm and 229.5 nm and minima at 275.5 nm, 266.5 nm and 245.5 nm. The second order spectrum of Baygon in alcohol (A3) shows maxima at 282.5 nm, 270 nm and 242.5 nm and minima at 286.5, 277.5 nm and 266 nm. The second order spectrum of Finit in alcohol (A4) shows maxima at 282 nm, 269.5 nm and 233.5 nm and minima at 273.5 nm and 266 nm. The second order spectrum of Hilmala in alcohol (A5) shows maxima at 291 nm, 280.5 nm, 269.5 nm, 260 nm, 251 nm and 231 nm and minima at 286.5 nm, 275.5 nm, 265 nm, 256 and 247 nm.

Conclusion

Derivative UV spectroscopy is an efficient technique for the identification of the pesticides when encountered in common beverages. The zero order can be used for elimination purpose, whereas, the first and second order derivatives can be used for more accurate identification. Shifts in peaks can be observed due to some interference of the matrices, however, the identification is possible even in cases where the pesticides are found in beverages. Derivative Ultraviolet spectrophotometry is less time consuming, easier to use, non-destructive, and sensitive technique with good accuracy and precision. The cost of analysis per samples is less compared to other techniques such as GC-MS, etc. Therefore, it can be successfully used for elimination as well as identification process.

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Conflict of interest: None to declare

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